



NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

THESIS

**LEARNING COMPETENCIES USED IN THE U.S.
NAVY'S VIRTUAL SCHOOLHOUSE LEARNING
ENVIRONMENT**

by

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December 2016

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SCHOOLHOUSE LEARNING ENVIRONMENT**

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ABSTRACT

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By surveying students participating in the U.S. Navy's Virtual Schoolhouse, we were able to attain and analyze quantitative data. We discovered that virtual world efficacy is a meta-competency composed of autonomous learning, multiple level operation, and collaborative adaptability. Our research findings suggest that a student's capability to understand and learn in the virtual world is a broad competency and is a significant predictor of his/her success in the virtual environment. Based on our findings, we recommend a familiarity period to allow students to develop these competencies prior to their participation in virtual learning.

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LIST OF ACRONYMS AND ABBREVIATIONS

DOD	Department of Defense
FTF	face-to-face
GAO	Government Accountability Office
GMT	general military training
NPS	Naval Postgraduate School
SLC	Submarine Learning Center
VLE	virtual learning environment
VSH	Virtual Schoolhouse

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I. INTRODUCTION

A. PROBLEM STATEMENT

As public pressure to minimize the United States' national debt increases, proportional pressure is placed upon the Department of Defense (DOD) and its service components (Army, Navy, Marines, or Air Force) to reduce its discretionary spending. For the U.S. Navy, specifically, growing sequestration techniques to reduce spending clash with the Navy's training requirements. While budget constraints increase, the Navy's need for effective and efficient training continues to grow.

The dollar cost of the Navy's training is significant and includes both quantitative and qualitative costs—the cost of manpower to develop the training curriculums, travel and lodging to learning or training sites, and the opportunity costs of loss of manpower and efficiency at commands with sailors away from their assigned duties receiving training. Additionally, traditional training at centralized Navy learning sites has the potential to impact sailors' morale, caused by traveling away from assigned job duties and family members. Traditional classroom training also tends to limit access for students to use tools relevant to the system for which they are receiving training. Self-paced practice on newly-learned skills is also typically unavailable in a Navy classroom setting. Current face-to-face (FTF) classroom training may not be the most effective method of training to meet the Navy's needs, given sailors' unique morale challenges, training needs, and the growing concerns of budgetary cognizance.

Distributed virtual learning may provide an opportunity to reduce costs while also improving training outcomes. Many organizations have explored the use of virtual technology, especially training organizations and academic institutions. A wealth of research exists on asynchronous dispersed learning. This research provides depth, providing opportunities to test and replicate existing scales, and to use this current research as an established foundation. However, little research has been conducted on dispersed synchronous virtual learning. Studies recently conducted by Kathryn Aten and

Marco DiRenzo conclude that training in dispersed synchronous virtual environments can be successful (Aten & DiRenzo, 2014).

Distributed learning as a technique is different than face-to-face classroom training and these differences must be addressed both in format of the training and pre-training student priming. Students and instructors are more familiar with face-to-face training as it retains the power of status quo. It relies on instructor direction it contains familiar visual communicative cues, and perceptions and attitudes toward training design contribute to the overall learning outcomes (Aten & DiRenzo, 2014). Most courses are designed for face-to-face training; however, this delivery method may not be the most effective or efficient. The majority of students are familiar with daily online communication and problem solving. Students may have enhanced access to learning tools and the opportunity to expand or enhance online communication and collaborative skills by using virtual learning applications. We must understand these differences and opportunities in order to design training programs to accommodate them and to fully leverage the benefits of dispersed synchronous virtual learning as a viable training approach.

B. BACKGROUND

1. Current Navy Training

The U.S. Navy's administrative, technical, and tactical training includes a plethora of available mediums. A sailor's training begins with introductory basic training and continues throughout the length of his or her naval career with periodic training, technical skill courses for specific systems, and tactical knowledge development. Sailors are trained using traditional lecture-style courses in addition to three-dimensional virtual simulators, if necessary, for their specialty. These types of training are typically conducted in large learning site facilities, called "schoolhouses," and are based onshore in fleet concentration areas such as Norfolk, Virginia and San Diego, California.

Schoolhouse training assignments can occur between operational duty assignments or may involve a temporary assignment away from existing duties. Sailors may be assigned to schoolhouses for a period of time ranging from a few days to several

months while developing proficiency in their associated systems. Temporary assigned duty away from permanent duty stations incur travel and lodging costs, often to the accrued point at which satellite schoolhouses are manned such as Naval Submarine Training Center Pacific Detachment Guam. Advancing the availability and enhancing the effectiveness of virtual distance learning can support the Navy's efforts to decrease overall spending on training while increasing each sailor's technical proficiency to maintain mission readiness.

The Navy's current personnel training regimen includes a mix of live and simulated training approaches to complete training objectives for general military training (GMT), technical and tactical development, and overall readiness. Simulated training is provided to sailors while at sea to accomplish the periodic training requirements for topics such as personal financial management, ethics, information assurance, and operational security practices. This training has been under deepening scrutiny as its ineffectiveness and costs have been publicized by performance audit reports conducted by the Government Accountability Office (GAO). In recent years, the Navy has dedicated resources to improve training effectiveness and continue to reduce training costs.

Each naval community—aviation, surface, and submarine—requires a unique blend of live and simulated training to maintain readiness. Since submarines utilize rotating crews (two crews are assigned to one submarine), submarine sailors not currently deployed conduct training with shore-based simulators prior to deployment because live training is not possible while the submarine is deployed with the alternate crew (Pickup et al., 2012). The existing virtual training in the submarine community has led to completing training objectives required for deployment readiness and has allowed the community to move forward in researching and developing effective virtual learning approaches for other training needs, as well (Pickup et al., 2012).

2. U.S. Navy's Use of Distance Learning at Submarine Learning Center

In effort to reduce training costs, the Navy's Submarine Learning Center (SLC) has developed and begun implementing a virtual schoolhouse (VSH) to provide synchronous distance learning for several submarine-related training courses. The SLC,

in cooperation with various industry and academic partners, developed the VSH in 2013 to provide a common training platform for its distributed learning needs (Aguiar & Wohlgemuth, 2016). Students participating in the VSH environment are represented by avatars and may communicate with one other and the instructor in real-time in addition to interacting with the various learning features and tools designed within the VSH, such as training aids, relevant technical publications, and learning exhibits. The learning resources available to students and immersive technology contribute to the VSH's goal of instilling a sense of presence in students so they focus less on their physical location and more on the virtual training environment.

C. PURPOSE

The following items constitute the purpose of this research. First, we will determine which VSH features and tools are most/least valued by Navy students so we can better understand which features students find most conducive to virtual learning. Second, we will investigate how instructor styles and tools contribute to students' learning success in the VSH. Third, we will identify key learning competencies that best address valued features so the appropriate features, coupled with the identified learning competencies, are emphasized during training. Fourth, we will build upon previously developed models which depict virtual environment learning competencies and their anticipated outcomes. Finally, we will discuss potential ways these learning strategies can most effectively be transmitted to students prior to their entering the virtual schoolhouse for actual training to ensure future students' success.

D. RESEARCH QUESTIONS

This study and the conclusions derived from the findings will be directed by three research questions. First, we must answer the question, "Which learning competencies best support learning in a synchronous virtual-learning environment?" To do so, we will test previously identified learning competencies, add any new and relevant competencies, and test and replicate existing scales for evaluating the effectiveness of the VSH.

Second, we will answer the question, "How can relevant learning competencies be transmitted to students during learning events?" This leads to directly to our third

research question, “Which, if any, individual-level cognitive factors can be extracted during the pre-training phase that positively influence students’ learning process?”

The fourth and final research question we seek to answer is, “Which learning competencies can be added to existing models on learning in virtual environments?”

E. APPROACH

The use of previous studies of synchronous, dispersed learning will be used for background information and study guidance. Relevant studies we will use include, but will not be limited to, organizational behavior, business management, and virtual education technology. Visual observations of the VSH during live student engagement and course offering will orient the researchers to the VSH technology. Students participating in courses using the VSH will be surveyed, and volunteering students will be interviewed to provide specific feedback. Survey and interview data will be analyzed to determine the VSH features and tools most valued by students. Finally, we will develop an enhanced student learning competencies model.

F. ORGANIZATION

This report begins with this introduction, which provides background information, the report’s purpose and approach, and the report’s research questions. Following this introduction is a literature review that examines the findings of relevant studies of the U.S. Navy’s requirement for virtual training, influential learning factors in virtual learning, observed competencies in synchronous virtual collaboration, and factors affecting training in synchronous dispersed virtual environments. Next, the method chapter will discuss the setting and methodology under which we conducted our studies. The following chapter will list all findings associated with our research. This report will end with conclusions, implications, and suggestions for future, related research.

G. SUMMARY

In response to the Navy’s challenges regarding budgetary constraints, the Submarine Learning Center has developed a virtual schoolhouse to facilitate the reduction of travel and lodging costs associated with required naval training courses.

Already developed and implemented, this report will ascertain the virtual schoolhouse's features and tools from the student perspective. The findings of this report will include an illustrative model of the learning competencies and strategies the Navy could incorporate in its use of the virtual schoolhouse in order to ensure effective and efficient synchronous, dispersed, and virtual learning while continuing to sequester costs incurred from temporarily assigning sailors away from their permanent duty stations for training.

II. LITERATURE REVIEW

A. LEARNING FACTORS IN SYNCHRONOUS VIRTUAL ENVIRONMENTS

Students' personal perceptions of the virtual learning environment (VLE) coupled with students' personality factors were found to determine virtual training effectiveness based on cognitive processes (Spears, 2014). Spears's study included research in the disciplines of psychology, education, and information systems to identify three categories which affect learning outcomes (2014, p. 32). The three categories were student perceptions, student preparation, and mediation processes (Spears, 2014, p. 32). These factors were found to contribute to students' successfully achieving desired learning outcomes. Using the three broad categories stated above, Spears further refined the factors which contribute to successful student learning outcomes.

Student personality factors include core self-evaluation, goal orientation, and regulatory focus (Spears, 2014). A student's core self-evaluation involves that student's self-perceptions regarding his or her personal capabilities, self-esteem, and ability to control his or her own destiny. Students who are confident in their own abilities are more likely to succeed academically than students who are not confident in their abilities. This likelihood of academic success also translates to the VLE. Goal orientation is measured by a student's motivation to achieve high performance scores or receive the most knowledge from the learning experience. A student's regulatory focus is essentially the link between motivation and goal achievement (Spears, 2014, p. xvii).

Comprehending a student's perceptions about a VLE provides insight to understanding student performance during learning events. The perspective of the students measures the effectiveness of a specific VLE (Spears, 2014). Perceived system performance addresses whether students find a VLE system to be helpful and convenient, utilizing factors such as usefulness, ease of use, technical performance, and communication richness (Spears, 2014).

Students' perceptions of their instructor in a VLE create a perception of the quality of execution with factors such as instructor attitudes, interactivity via the VLE, and technological competence (Spears, 2014). Instructors' attitudes toward VLE technology affect student attitudes towards VLE. Instructors use of interactivity features to complement their teaching styles while interacting with students via the VLE is crucial to well-received student perceptions. Additionally, an instructor's technical ability to effectively operate the VLE technology is also imperative to positive student perceptions.

Mediating processes include cognitive attitude and cognitive engagement. Attitude, by definition, is a person's feelings, whether negative or positive, regarding performing a specific task or behavior (Spears, 2014, p. 18). Cognitive attitude mediates the influence of a student's perceived usefulness and perceived ease of use of VLE technology (Spears, 2014, p. 18). The definition of cognitive engagement is "the quality of students' psychological engagement in academic tasks, including their interest, ownership, and strategies for learning" (Spears, 2014, p. 17). Cognitive engagement is a predictor of a student's academic success as it depends on the quality of a student's efforts to understand or master a learning outcome.

Personality factors and perceptions influence student cognitive processes, which enable students to achieve learning outcomes, as shown in Figure 1. Spears's study concluded that a synchronous, dispersed learning environment with restrictive learner control was the most plausible Navy training application.

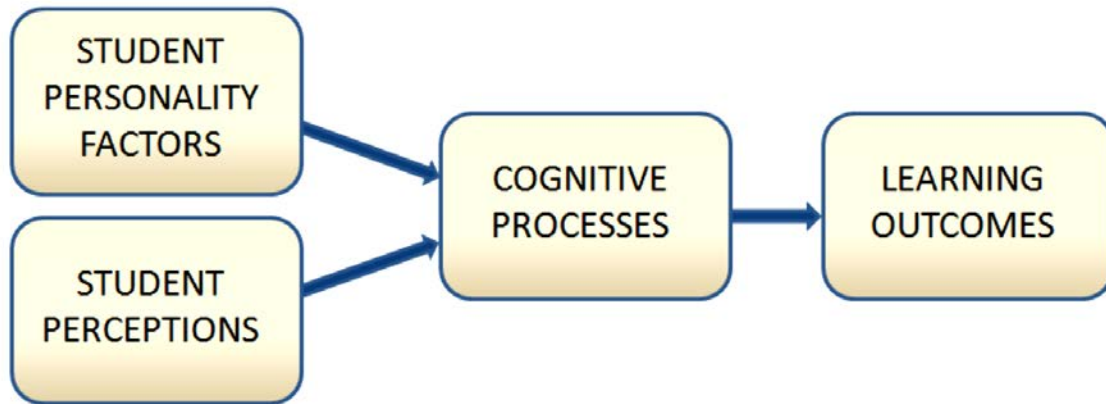


Figure 1. Conceptual Framework of Learning in Synchronous Virtual Environments. Source: Spears (2014).

B. COGNITIVE LEARNING PROCESSES AND OUTCOMES IN THE VIRTUAL SCHOOLHOUSE

This study built directly on Spears’s model and conclusions and tested some of the conceptual relationships outlined by Spears by exploring the following two questions:

1. “What role do cognitive factors and processes play in performance and satisfaction outcomes of education and training conducted in virtual worlds?” and;
2. “What adaptations to behavior and communication can improve education and training in virtual worlds?” (Aten & DiRenzo, 2014, p. 2).

Aten and DiRenzo’s study at the Fleet Anti-Submarine Warfare Training Center compared the virtual schoolhouse to Face-to-Face (FTF) training and were able to synthesize Spears’s conceptual model into three core competencies. Students’ success in achieving learning outcomes in VLEs were found to be dependent upon student cognitive competencies, perceptions of the learning system and instructors, and cognitive processes (Aten & DiRenzo, 2014).

A student’s cognitive competencies consist of cognitive capacity, multimedia self-efficacy, self-regulated learning, and regulatory focus (Aten & DiRenzo, 2014). Aten and DiRenzo’s study measured students’ intellectual capability, or cognitive capacity, by capturing test performance scores on previous modules (2014, p. 4). Comfort and competency operating communications technologies identifies a student’s multimedia

self-efficacy. Self-regulated learning is a student's ability to direct autonomous and proactive learning. As found in Spears's research, regulatory focus is a student's motivation by either promotion or prevention. Promotion focus encompasses a student's motivation to earn awards and achieve goals, whereas prevention focus is a student's motivation to avoid punishment or failure (Aten & DiRenzo, 2014, p. 4).

Perceptions of the learning system includes students' perceptions of the usefulness and ease of use of the VSH, as well as features which enable interactivity with the instructor and learning materials access. Students' perceptions of the instructor's quality and knowledge, plus the students' perceptions of the instructor's attitude toward interacting within the VSH, all influence students' overall perceptions of the VSH.

Similar to, and deriving from, Spears's findings, Aten and DiRenzo state cognitive engagement and cognitive attitudes comprise the cognitive processes which identify student interest and beneficiary attitudes towards learning in the VSH.

Utilizing Spears's conceptual framework, Aten and DiRenzo expanded and tested individual-level factors which contribute to learning and satisfaction success in virtual learning environments. Although the sample size was small, study findings suggest that "virtual environments are a viable alternative for the delivery of education and training" (Aten & DiRenzo, 2014, p. 8). Performance scores on knowledge and practical tests were slightly higher for VSH students, while FTF students reported more positive attitudes in classroom and lab training. Additionally, Initial Entry sailors did not perform as well as Fleet Returnees; and cohorts with a mix of Initial Entry sailors and Fleet Returnees scored higher than the cohort of all Initial Entry sailors. Using these findings, plus those from Spears's study, the Aten-DiRenzo model, depicted in Figure 2, was created to illustrate the causation of the predictive relationships between the four student cognitive factors, student perceptions of the learning system and instructors within it, cognitive processes, and student learning outcomes.

The study conducted by Aten and DiRenzo recommends student preparation for learning in VSH with pre-training and priming (2014, p. 19). Due to the self-regulatory requirements of virtual learning, students should be trained with basic skills to best take

control of their learning and plan, monitor, and evaluate the effectiveness of their learning throughout the VSH experience. Instructor preparation should include priming them to express enthusiasm regarding teaching in the VSH and be trained competently on the operation of the VSH features and tools (Aten & DiRenzo, 2014, p. 20). Lastly, the study recommends learning system design should be enhanced to increase student-instructor interaction between one another and the learning content (Aten & DiRenzo, 2014, p. 20).

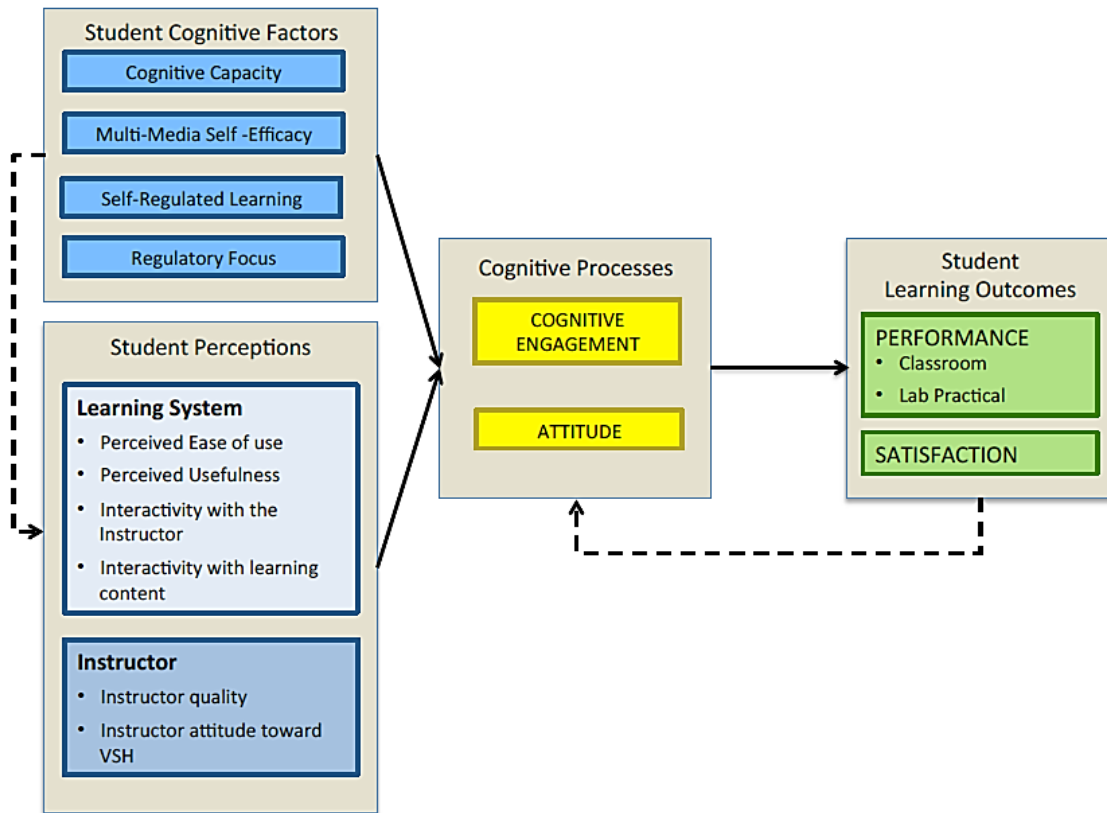


Figure 2. Model of Learning in Virtual Environments.
Source: Aten and DiRenzo (2014).

C. COMPETENCIES FOR WORKING IN VIRTUAL WORLDS

The next step in the evolution of this research stream was the study conducted by Aten, DiRenzo, Stanko, Lahneman, Nardon, and Richter in 2014. This study scrutinized two additional studies and developed the framework of four

competencies attributable to virtual learning effectiveness. The Aten et al. study drew on three exploratory, qualitative studies, which examined teams conducting work in virtual worlds to identify key competencies for effective virtual work.

The first of the three studies, “Working Out Loud,” was based on an in-depth study of a case of successful collaborative knowledge work by a distributed group working in a virtual world (Aten et al., 2014). “Plastic Prometheus” was the second study and analyzed in-depth interviews of individuals working in three-dimensional virtual environments to examine affordances that emerge around daily use of technology for work and how they relate to work routines (Aten et al., 2014). The third study, and the one on which our research is built, was conducted during a test of the Navy’s Submarine Learning Center (SLC) virtual schoolhouse (VSH). According to the study, “the VSH enabled distributed instructors and students, represented by avatars, to interact with each other and to access live tactical systems across distance in a 3D virtual environment” (Aten et al., 2014).

Findings from these three studies suggest four learning competencies which involve key knowledge, skills, and attitudes that are required for effective learning in virtual environments. These four competencies identified were a student’s ability to “(1) articulate thoughts and actions in ways that differ from face-to-face communication, (2) use technology to conduct communication on multiple (often simultaneous) levels and in multiple timeframes, (3) accept contextual ambiguity and adopt alternate perspectives and identities, and (4) develop and maintain positive affective and cognitive attitudes toward virtual world technology” (Aten et al., 2014, p. 25).

Since communicating in virtual environments lacks the physical cues and body language of face-to-face communication, thoughts and actions must be articulated differently in order to be effective. Individuals working in virtual worlds need to be able and willing to adapt their behavior for working in virtual environments. Individuals need to be able to articulate their thoughts and actions as they conduct work so that other team members can construct a rich visual representation of the action being taken. They need to make evident their strategy and thought processes behind the action in the absence of cues that are often present in a face-to-face setting.

The use of technology to conduct communication on multiple and/or simultaneous levels also creates unique challenges for individuals interacting in virtual environments. Those conducting work in virtual environments require skills to communicate layers of meaning and maintain the flow of work and interaction despite barriers as well as the absence of cues and the routines they trigger. Individuals must be able to navigate across multiple technological platforms which support and sustain interaction.

Individuals must be able to model and visualize new products, or to be able to walk into life-size prototypes and understand how different elements are spatially related to one another. This allows individuals to readily accept contextual ambiguity and embrace different perspectives and identities.

Without the ability to maintain positive affective and cognitive attitudes towards the technology that is used, individuals participating in the VSH are less open and unable to adapt their behaviors in the ways that are critical for successful virtual learning. Therefore, it is imperative that individuals develop and maintain positive attitudes toward virtual environment learning technologies.

In sum, the study conducted by Aten et al. derived four competencies from three previous, relevant studies. One singular competency is insufficient alone for success in the VSH. Each competency is intertwined and must be present for success in the VSH. In addition to the studies discussed above, studies by Nakayama, Yamamoto & Santiago, “The Impact of Learner Characteristics on Learning Performance in Hybrid Courses among Japanese Students,” and M. Bower, “Synchronous Collaboration Competencies in Web-Conferencing Environments,” also offered additional insight in to potential competencies leading to student success in the VSH.

D. THE IMPACT OF LEARNER CHARACTERISTICS ON LEARNING PERFORMANCE IN HYBRID COURSES

In this 2007 study, Nakayama, Yamamoto, and Santiago examined the learning characteristics and performance of 84 students at Tokyo’s Institute of Technology by analyzing students’ test modules performance scores (p. 195). Students self-assessed their online learning experience to identify possible causal paths to learning performance

based on learning characteristics. Students were Bachelor's program freshmen and Masters' students in a hybrid course that mixed face-to-face learning with online learning.

Based on the data Nakayama et al. gathered, three learning factors were constructed: e-Learning overall evaluation, learning habits, and learning strategies (Nakayama et al., 2007, p. 199). These three learning factors which can be aligned with and support several items in the Aten-DiRenzo (2014) Model of Learning in Virtual Environments. Factor 1, "overall evaluation of e-learning experience," includes items that measure perceived ease of use ('E-Learning is easy to follow and understand') and perceived usefulness ("Online materials are useful to me") (Nakayama et al., 2007, p. 199). Factor 2, "learning habits," includes items which measure self-regulated learning ("I'm a conscientious student," and "It is my habit to do learning preparation and review") (Nakayama et al., 2007, p. 199). Factor 3, "learning strategies," includes items that also measure self-regulated learning ("I have my own method and way of learning" and "I have my own strategies on how to pass a course") (Nakayama et al., 2007, p. 199).

Differences were discovered in conscientiousness between students who earned final grades of "A" and "B" in the course, suggesting student personality affects final grades (Nakayama et al., 2007, p. 205). Master's students had higher "learning strategy" scores than Bachelor's students, indicating that Master's students may have positively recognized the benefits of online courses (Nakayama et al., 2007, p. 205). These students likely developed strategies (e.g., "access to online modules during that time of day when they are most ready to study and learn") themselves as an application of self-regulatory focus (Nakayama et al., 2007). Learner characteristics were found to have affected learning experience and performance. Learner characteristics—"motivation, personality, thinking styles"—and learners' perception of their e-Learning experiences were measured at the beginning and end of the term, and master students' perception of their e-Learning experience increased significantly throughout the course (Nakayama et al., 2007, p. 205).

E. SYNCHRONOUS COLLABORATION COMPETENCIES IN WEB- CONFERENCING LEARNING ENVIRONMENTS

M. Bower's study conducted in 2010 observed four levels of online collaborative competencies with impact the online learning process: operational, interactional, managerial, and design (M. Bower, 2010, p. 63). The study analyzed 26 college students over three academic semesters using multi-modal pedagogies to refine the discovered competencies (M. Bower, 2010, p. 67).

The first competency identified, operational, is one's ability to operate the functions of the collaborative environment technology (M. Bower, 2010, p. 76). These are the easiest to develop due to the relatively simple repetition of tasks in the virtual environment; however, operational competencies require additional practice to become proficient. Such repetition allows for quick adaptation for both students and instructors. Common operational functions, such as text chat, whiteboard use, screen board rotation, and the uploading and downloading of files, are executed by the student and instructor early and often enough they can facilitate an organically developed adaptation of many operational competencies.

Interactional, the second competency, is one's "ability to effectively interact to perform" tasks and solve problems using the collaborative technology by forming an understating of who is manipulating the virtual environment and for what purpose (M. Bower, 2010, p. 76). Understanding who is contributing to the virtual learning environment helps to "overcome distributed process loss by providing people with" an awareness of others' actions and the center of concentration (M. Bower, 2010, p. 76). For example, the student will react differently if the instructor is manipulating an element of the VSH as opposed to a fellow student. Capturing this information can be accomplished by adding initials to notepad contributions and using audio to indicate the focus of attention.

The third competency, managerial, is the ability to manage the class including effective technology use and interaction (M. Bower, 2010, p. 76). This competency applies to instructors and, if poorly applied, could cause negative ripple effects throughout the classroom.

The fourth and final competency identified by M. Bower is design, defined as the ability to select and organize tools to optimize interaction and support activity management (M. Bower, 2010, p. 76). Understanding the representational and interactional potential of the different tools provided in the virtual classroom allows for the maximum participation and interaction between the instructor and students. Used not only to assist in fostering the development of the Interactive competency, but in all functional aspects of the VSH. The arrangement of different tools can be conducted by either the instructor prior to the beginning of class or by the students during a learning episode. Since different tools are required for different classes, effective design of the VSH requires that both the instructor and the students understand the different functional, representational and interactional potential of tools.

Competencies derived from synchronous collaborative learning are dependent upon the type of pedagogies being applied (M. Bower, 2010, p. 80). Instructor-centered learning requires lower levels of managerial competencies of the instructor, but higher operational competencies of students. Student-led learning requires the instructor to have greater managerial and design competency, while students will likely exercise some managerial competencies as well.

F. SUMMARY OF LITERATURE REVIEW

In assessing and comparing the relevant data, we discovered seven learning competencies which may best predict student learning outcomes in VLEs. All four of Aten's competencies, Aten and DiRenzo's self-regulated learning, and M. Bower's operational and interactional competencies would likely best predict student learning outcomes (Aten, 2014; Aten & DiRenzo, 2014; M. Bower, 2010). In addition, Aten's four competencies—articulating thoughts and actions in a collaborative environment, using the technology to communicate on multiple levels, accepting contextual ambiguity, and maintaining positive affective and cognitive attitudes—signal prediction of students freely accepting training and collaborating via the VLE technology (2014). Their physical and cognitive ability to collaborate can also be predicted using M. Bower's operational

and interactional competencies. Finally, a student's self-regulated learning abilities are required to successfully achieve desired VLE learning outcomes.

G. THEORETICAL MODEL DEVELOPMENT

Based on the relevant literature reviewed, we expected to see strong correlations among all seven identified learning competencies listed above. Due to the specific nature of Aten's four competencies, we predicted they would likely be more descriptive of the two competencies identified by M. Bower. Additionally, the competency, self-regulatory learning, was expected to have relatively strong correlations to the other competencies measured in the study.

Figure 3 illustrates our anticipated adapted model, using Spears and Aten's models from Figures 1 and 2, respectively, and refining the learning competencies to demonstrate the influence of the seven anticipated competencies we have identified. All seven competencies are listed under "Student Competencies" and can likely be taught and/or improved upon before a student begins VSH course work. "Student Perceptions" include the student's perceptions of the VSH learning system and the instructor, which cannot be taught or primed prior to engaging in VSH courses. Student competencies and perceptions will influence their cognitive processes—cognitive engagement and attitude—ultimately affect the desired learning outcomes, both performance and satisfaction.

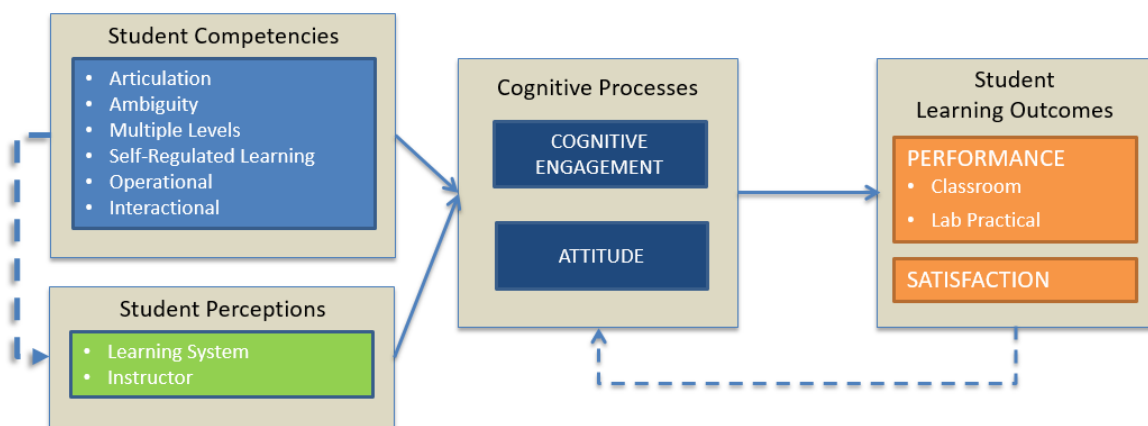


Figure 3. Theorized Model of VSH Learning Competencies

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III. METHOD

A. PROJECT PURPOSE

The overall purpose of this project is to create an illustrative model of the learning competencies which contribute to successful learning in the VSH. Using the Aten and DiRenzo study, “Assessing the potential of virtual worlds for Navy Training and Education: cognitive learning processes and outcomes in the virtual schoolhouse” as a basis for this project, we expanded the sample size of students surveyed from the original 36 students to 39 additional students. We replicated Aten and DiRenzo’s study by observing three training sessions and administering surveys to students. While refining the Aten-DiRenzo model, we will analyze our research findings to add new, relevant learning competencies.

B. SETTING

The students were set in classrooms which contained desktop computer systems that were connected to the VSH program network. The classrooms were located in Groton, Connecticut; Kings Bay, Georgia; and Norfolk, Virginia. Classroom organization varied between each location and training session—some sessions had a senior enlisted proctor present to address questions regarding operating the VSH and computers, some sessions did not have any staff members present for the training. Students in the three geographical locations mentioned above participated in three different courses, each three days in length, and conducted solely via the VSH. From the students participating in the VSH, volunteers were identified to remotely provide via interviews at a later date their personal observations and perceptions while using the VSH.

Site visits were conducted in May to observe students’ participation in the VSH and administer surveys. Surveys administered in May were conducted by hand. A total of 39 students participated in VSH courses. The VSH courses were hosted by an instructor in Groton, Connecticut, and taught students located in Groton, Connecticut; Norfolk, Virginia; and Kings Bay, Georgia via the VSH collaborate computer system.

C. SURVEY

The surveys were designed to assess students' perceptions of the VSH and determine which learning competencies are being transmitted during training. While developing questions for the survey, we used Aten and DiRenzo's previous study's survey as a base. From that base, we added questions which were relevant to the virtual environment learning competencies previously identified during our literature review. These included the following competencies:

1. Articulate thoughts and actions in a collaborative environment (Aten et al., 2014);
2. Use the technology to communicate on multiple levels (Aten et al., 2014);
3. Accept contextual ambiguity (Aten et al., 2014);
4. Develop and maintain positive affective and cognitive attitudes (Aten, et al, 2014);
5. Operational (M. Bower, 2010);
6. Interactional (M. Bower, 2010); and
7. Self-regulated learning (Aten et al., 2014).

Surveys were completed by students before beginning their VSH orientation at the very start of the training session and then administered post-training. The pre- and post-training surveys given to students can be found in Appendix A and Appendix B, respectively.

D. FOLLOW-UP INTERVIEWS

At the conclusion of the site visit, students at all three locations were asked if they would be willing to sign a waiver, and agree to participate in an oral interview at a later date. Eleven of 39 students signed the waiver; out of the 11 students who signed the waiver, the researchers were able to contact and interview five students. The five interviews that were conducted generated 134 minutes of narrative consisting of answers to 18 pre-determined questions, listed in Appendix C. The interview questions were chosen based on their ability to elicit responses from students that could be associated with the learning competencies identified in previous studies. Students were encouraged

to provide specific examples of events that occurred during the actual course. The interviews were conducted over the phone, recorded, and transcribed.

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IV. FINDINGS

A. LEARNING COMPETENCY INTER-RELATIONSHIPS

The data were analyzed using the correlational analysis among the competencies. The competencies included the seven identified in Chapter II of this study, as well as other competencies and competency subscales from Aten and DiRenzo's previous study designs (2014). Appendix D illustrates the correlation relationships between all competencies studied. Our primary goal for this study was to identify and examine how the student learning competencies inter-relate with one another. By examining the correlation matrix, we were able to determine which competency constructs strongly and positively influence one another. Table 1 illustrates the most significant correlations between the learning competencies.

Table 1. Significant Correlation Data between Learning Competencies

r	Internet Competency	Virtual World Efficacy	Operational	Interactional	Ambiguity	Multiple Levels
Internet Competency	1	.736	.589	.750	.679	.515
Virtual World Efficacy	.736	1	.771	.853	.781	.642
Operational	.589	.771	1	.688	.792	.771
Interactional	.750	.853	.688	1	.770	.751
Ambiguity	.679	.781	.792	.770	1	.844
Multiple Levels	.515	.642	.771	.751	.844	1

Correlation data with significance of $p \leq 0.05$

The correlation analysis, coupled with the existing research discussed previously, suggest an important key finding. Virtual world efficacy (VWE) appears to be the most overarching of all the competencies measured. As shown in Table 1, VWE was strongly correlated with internet, operational, interactional, and ambiguity competencies, while also exhibiting positive correlations with all other competencies studied (see Appendix

D). Based on this key finding, we have re-conceptualized seven competencies identified in Chapter II. We elaborate on this re-conceptualization below.

B. MODEL RE-CONCEPTUALIZATION

The technological nature of the VSH suggests that the learning competencies which may best be developed in students in order to achieve learning outcomes are subsets to the students' ability to operate the VSH technology and their comfort in doing so. The importance of students' virtual world efficacy in their VSH success suggests that it represents a meta-competency, being comprised of various other competencies that, together, may enhance student learning in a virtual world. Hence, as shown in Figure 4, we present the Bower-Richmond model of student competencies in the virtual learning environment, which suggests that success in the virtual learning environment is driven by an over-arching competency (virtual world efficacy), comprised of three distinct, yet related, dimensions (autonomous learning, multiple level operation, and collaborative adaptability). We discuss these competencies in detail in the following sections.

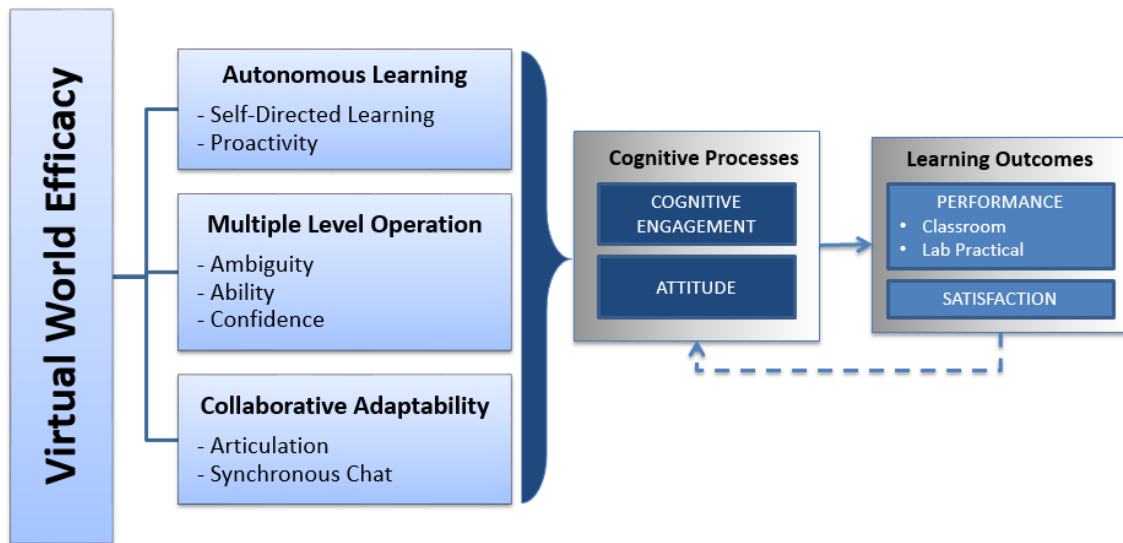


Figure 5. Bower-Richmond Model of Student Competencies in the Virtual Learning Environment

Virtual world efficacy (VWE) represents a student's ability to understand and learn in a virtual environment. Students must be competent in using communications technology in order to successfully achieve desired learning outcomes in the virtual environment. This entails not just operating the virtual environment technology—such as moving an avatar, adjusting the zoom level of the virtual classroom, or navigating around the virtual classroom—but also maintaining several conversations with multiple participants in a synchronous chat and simple internet operations like opening a web browser or switching between different windows. Because it encompasses a broad array of capabilities and related to all other competencies, virtual world efficacy represents the top-tier learning competency based on our findings. The second-order tier contains autonomous learning, multiple level operation, and collaborative adaptability.

Autonomous learning represents a student's ability to direct his or her own learning both independently and proactively. This competency includes factors such as the student's capacity for self-regulated learning, which has been discussed previously. Students must be able to make conscious and informed decisions without coercion or prompting from instructors to learn effectively in the virtual environment. This is especially true in learning in the virtual world, when cues from instructors typical in FTF learning may be absent.

Multiple level operation represents a student's ability to, and confidence towards, using the features and tools of the virtual environment. This competency is an expansion of Bower's (YEAR) "operational" competency. It includes simultaneously communicating across various virtual platforms and across *multiple levels*, such as the virtual classroom and virtual practical laboratory. Multiple level operation also requires the student to readily accept *ambiguity* in the virtual world context and embrace different perspectives and identities while performing virtual learning tasks. The subsets of this competency, shown in Figure 4, are primarily derived from Aten and DiRenzo's (2014) study and incorporate the definitions of their identified ambiguity and multiple levels competencies.

Finally, **collaborative adaptability** represents as a student's ability to collaborate with the technology, instructor, and other students to perform learning tasks and solve virtual problems. Again, this competency is an expansion and re-conceptualization of M. Bower's (2010) interactional competency and is also likely related to one's multiple level operation competency as well. Students must understand the need for *adaptability* in order to successfully interact with not only the instructor, but their fellow students and the virtual technology as well. This requires adapting to ways of *articulation* so as to appropriately convey and receive intended communications and messages. As such, mastering communication via *synchronous chat* is vital to effective collaboration.

C. COMPETENCY EFFECTS ON COGNITIVE PROCESSES AND LEARNING OUTCOMES

Our next goal was to examine the relationships between these competencies and both cognitive processes and final learning outcomes in the virtual world learning environment.

1. Cognitive Processes

The correlation data suggests many relationships that influence a student's cognitive processes. These processes include cognitive engagement in the areas of curiosity, focus, and interest; and affective and cognitive attitudes. The most significant findings were the strong relationships present between collaborative adaptability and the cognitive processes. Collaborative adaptability was related to curiosity ($p \leq 0.01$, $r = 0.785$), focus ($p \leq 0.01$, $r = 0.766$), interest ($p \leq 0.05$, $r = 0.607$), affective attitude ($p \leq 0.01$, $r = 0.759$), and cognitive attitude ($p \leq 0.01$, $r = 0.727$).

The data suggests that the most influential competency that affects a student's cognitive processes is collaborative adaptability. Relationships between cognitive processes and both autonomous learning and multiple level operation were not found to be significant. Nevertheless, due to the inherent difficulty of obtaining significant relationships with such a small sample size, we conducted further descriptive analysis regarding multiple level operations and autonomous learning. We divided the sample according to highest and lowest quartiles in terms of the students' rankings of both

autonomous learning and multiple level operations. We then found the average score for these groups for each of the five competencies of cognitive process to determine the nature of the relationship between autonomous learning and cognitive process and multiple level operations and cognitive processes. We found that students in the top quartile with respect to multiple level operation later rated their cognitive engagement and attitudes more highly compared to the last quartile of students. This suggests that higher multiple level operation is likely to enhance the cognitive processes. Figure 6 illustrates the top quartile (Q1) and the bottom quartile (Q4) students with respect to multiple level operation and their corresponding affective and cognitive attitude scores. Figure 7 shows the relationships between multiple level operation and the three forms of cognitive engagement. Similarly, Figures 8 and 9 reflect the top and bottom quartiles with respect to autonomous learning and their associated attitude and cognitive engagement scores as well.

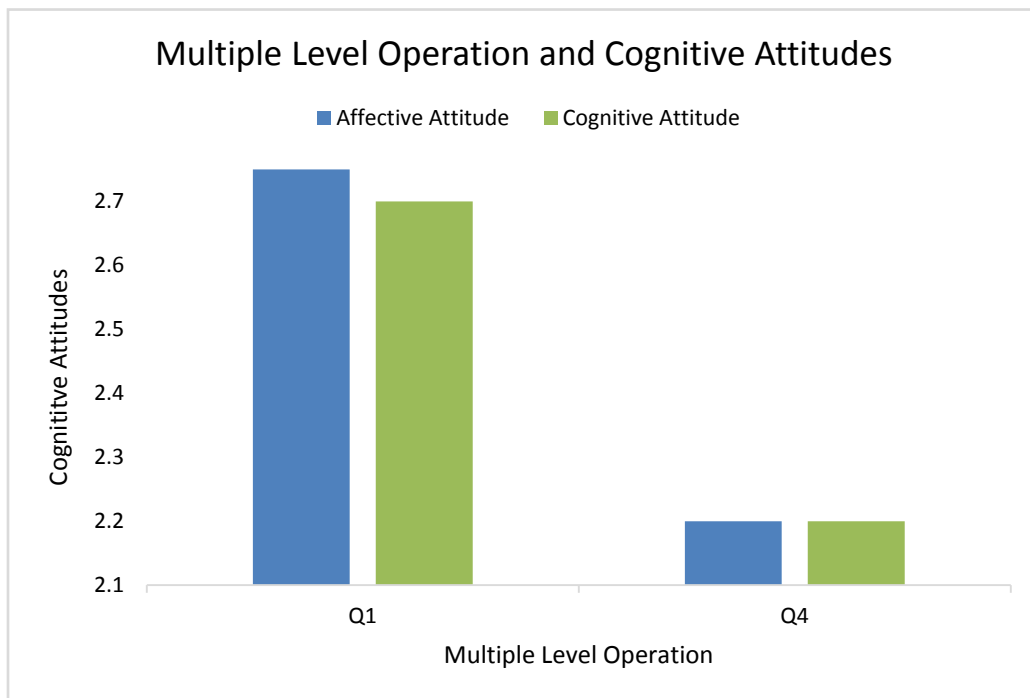


Figure 6. Multiple Level Operation and Cognitive Attitudes

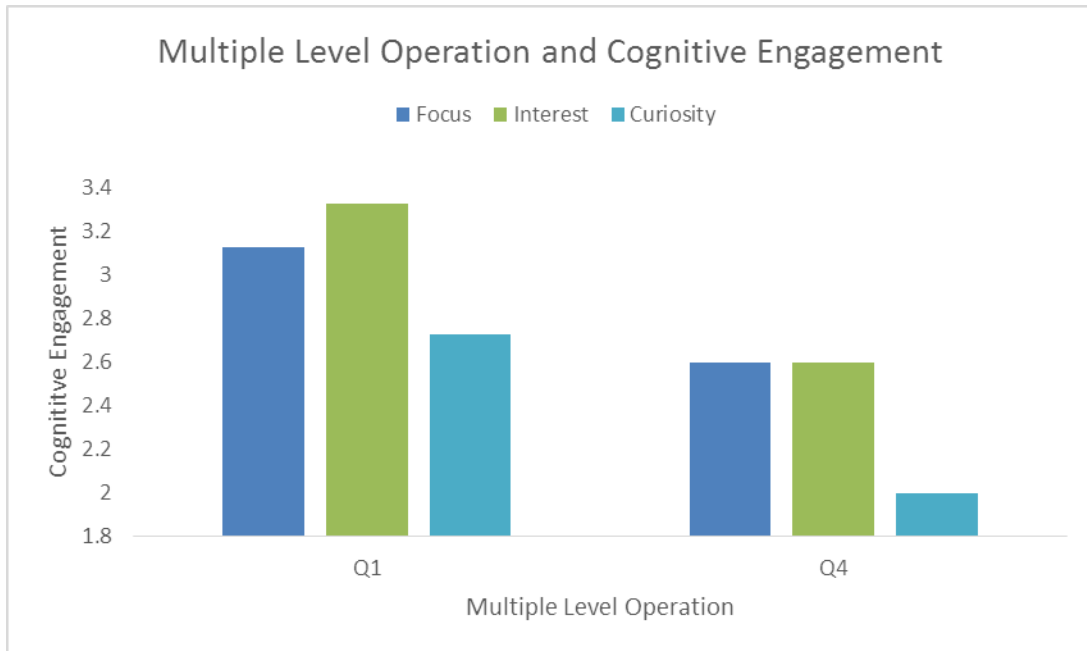


Figure 7. Multiple Level Operation and Cognitive Engagement

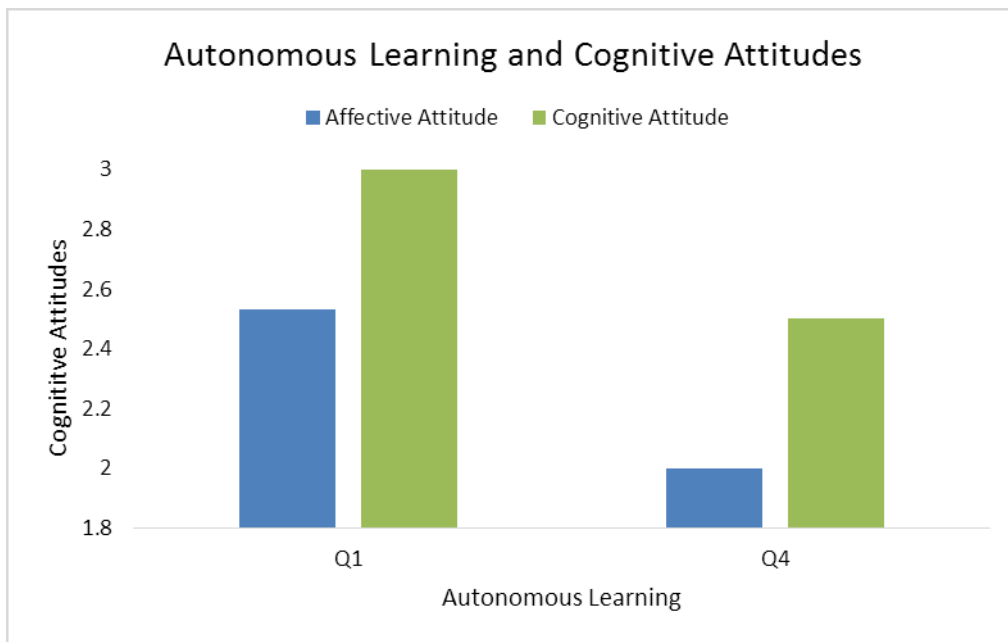


Figure 8. Autonomous Learning and Cognitive Attitudes

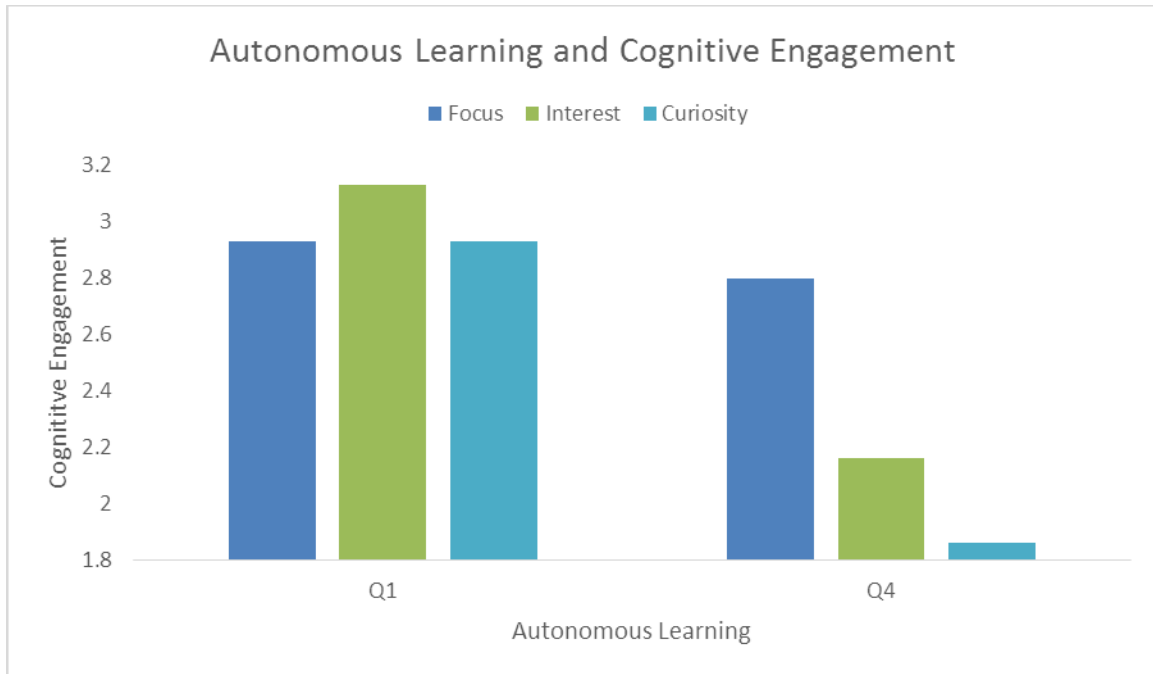


Figure 9. Autonomous Learning and Cognitive Engagement

2. Learning Outcomes

Our analysis of the correlation data also determined relationships that influence a student's achievement of learning outcomes. Final performance score and course satisfaction represent important learning outcomes set forth by the course objectives. Strong relationships were exhibited between collaborative adaptability, again, and learning outcomes. Collaborative adaptability was positively related to final score ($p \leq 0.05$, $r = 0.423$) and satisfaction ($p \leq 0.01$, $r = 0.747$). All dimensions of cognitive engagement (curiosity: $p \leq 0.01$, $r = 0.71$; attention: $p \leq 0.05$, $r = 0.51$; interest: $p \leq 0.01$, $r = 0.82$) and attitude (affective: $p \leq 0.01$, $r = 0.83$; cognitive: $p \leq 0.01$, $r = 0.76$) were also positively related to student satisfaction. Interesting though, none of the cognitive process was significantly associated with the student's final score. Hence, in the VSH, the cognitive processes are very important to enhancing student satisfaction with the course, but appear to have less impact on their test scores.

The data suggests collaborative adaptability also strongly influences a student's ability to successfully pass the final performance examination and their satisfaction of the course. This leads us to determine that collaborative adaptability is the primary driver of success in the VSH, directly relating to student's cognitive processes and learning outcomes. Relationships between learning outcomes and both autonomous learning and multiple level operation were not found to be significant. Again, due to the inherent difficulty of obtaining significant relationships with such a small sample size, we conducted further descriptive analysis regarding multiple level operations and autonomous learning.

As with their relationships with the cognitive processes, and as reflected in Figures 10 and 11, the data suggests that these relationships also trend in the expected directions as illustrated in our model.

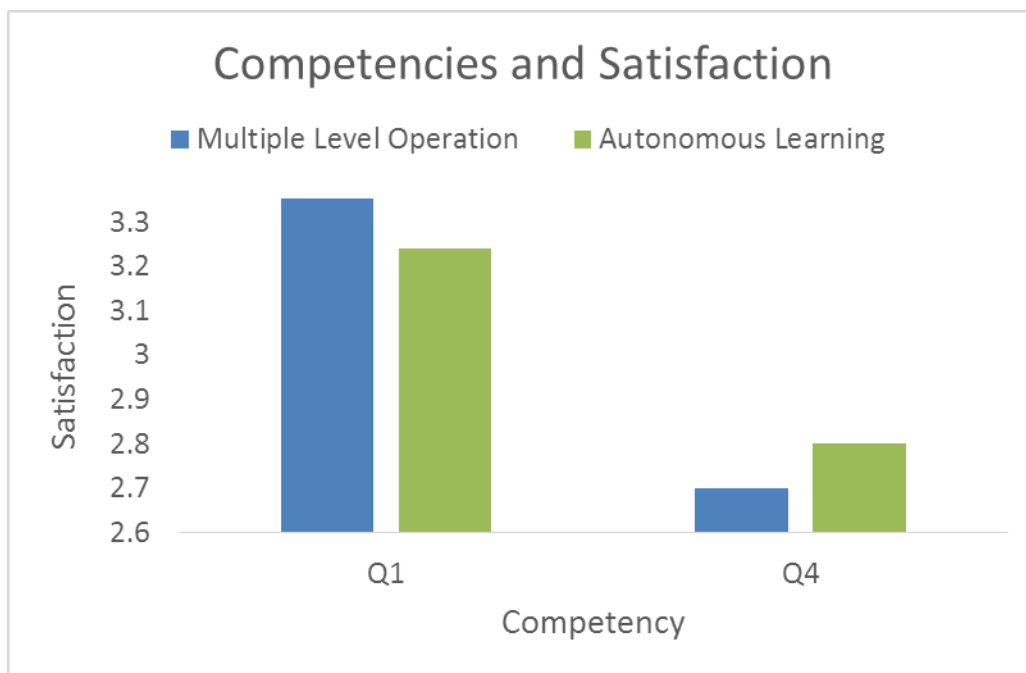


Figure 10. Competencies and Satisfaction

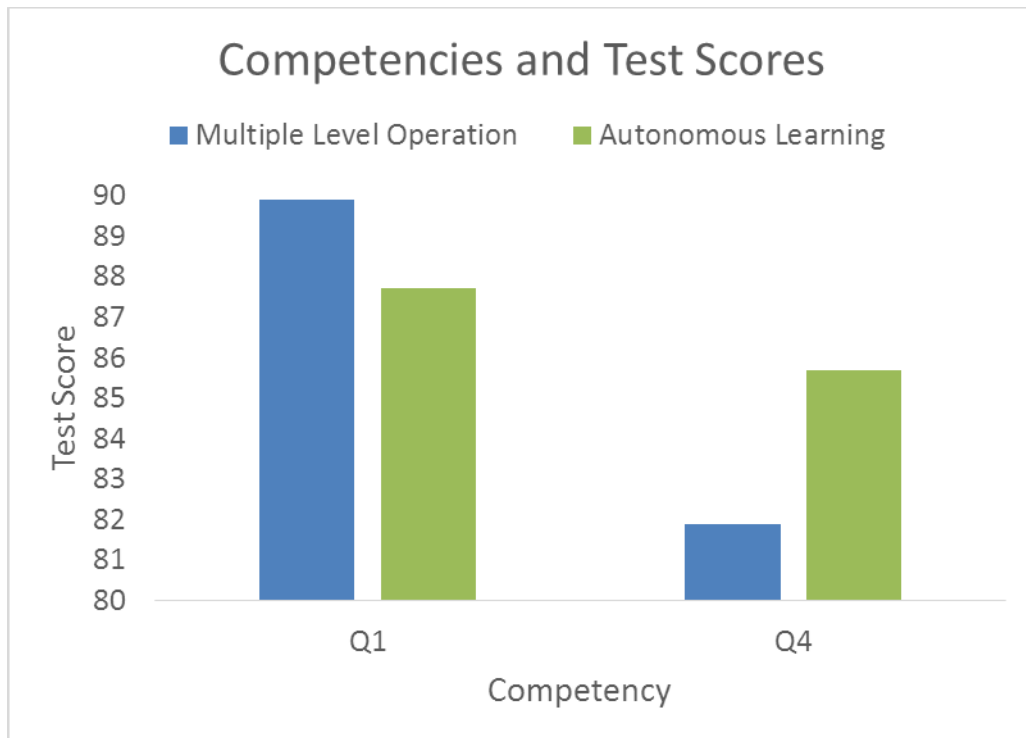


Figure 11. Competencies and Test Scores

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V. DISCUSSION AND CONCLUSION

A. SUMMARY

While Navy budget constraints are increasing with continuing resolve, the demand for more efficient and effective training is also increasing as the Navy strives for professional, proficient sailors. Previous research conducted at Naval Postgraduate School (NPS) has resulted in a wealth of understanding regarding the unique student competencies that may help enhance learning using virtual classroom technology.

Our goal for this study was to extend previous Spears and Aten-DiRenzo research findings to further clarify and enhance the VSH learning competencies model (Aten & DiRenzo, 2014; Spears, 2014). The specific goal of our research was to refine, introduce, and/or identify student success factors and competencies in a synchronous distributed virtual learning environment.

In order to collect the relevant student data, we conducted three simultaneous onsite visits to VSH locations in Norfolk, Virginia; Groton, Connecticut; and Kings Bay, Georgia. While at these locations, we used a refined list of survey questions derived from our literature review to administer anonymous pre- and post-surveys, in addition to obtain preliminary agreements for follow-on oral interviews in order to collect data in three areas. First, we wanted to identify which features and tools students found either beneficial or detrimental to their VSH experience. Second, we wanted to examine how instructor features and tools contribute to a student's VSH learning experience. Third, we wanted to identify new, as well as verify existing, student learning competencies that could contribute to a student's success in VSH courses. Our overall intent was to refine and simplify, if possible, the Aten-DiRenzo model for learning in the virtual world to reflect our findings.

A quantitative analysis was conducted based on the data gathered from pre- and post-class surveys that were originally developed by Aten and DiRenzo, which we expanded with additional questions inspired by our literature review (2014). Our statistical and literature review of the seven competencies tested—adaptability,

ambiguity, articulation, interactional, multiple levels, operational, and self-regulated learning—led to our findings in terms of new or refined competencies and subsequently the Bower-Richmond Model for student learning competencies in the virtual environment.

Our first finding was that a student’s virtual world efficacy—one’s capability to understand, operate, and learn in the virtual world—strongly correlated with nearly every other attribute, indicating that this broad competency was the single most significant predictor of a student’s success in achieving desired learning outcomes in the VSH. It was determined that virtual world efficacy would be our top-tier competency from which all other competencies would be derived. Virtual world efficacy also positively influenced the student’s applications of the operational, interactional, and self-regulated learning competencies.

Stemming from virtual world efficacy are our second-tier learning competencies and their associated subset competencies. This is illustrated in Figure 4 by the solid lines from “Virtual World Efficacy” to the three identified competencies, re-conceptualized them to “Autonomous Learning,” “Multiple Level Operation,” and “Collaborative Adaptability.” First, the operational competency statistically correlated with multiple levels and ambiguity competencies. Incorporating the definitions of multiple levels and ambiguity, we revised the operational competency as “multiple level operation.” We expanded the operational competency to encompass a student’s ability to operate and communicate in multiple levels in the VSH, while accepting contextual ambiguity in the virtual world.

Next, the interactional competency statistically correlated with articulation, adaptability, and synchronous chat competencies. We merged the definitions of articulation in the virtual environment, adaptability, and synchronous chat to revise the interactional competency. We then chose to revise the interactional competency “collaborative adaptability” to accurately describe the tenets of the competency.

Finally, self-regulated learning correlated logically with the overall concept of learning in the virtual environment. Students must possess an appropriate level of

autonomy in order to learn independently, without prompting from instructors, and proactively so they can achieve the desired learning outcomes. We revised self-regulated learning “autonomous learning,” which encompasses a student’s self-directed learning approaches.

Collectively, these correlations led to the development of the Bower-Richmond model for student learning competencies in the virtual learning environment. The model illustrates virtual world efficacy as the meta-competency, followed by the secondary competencies of autonomous learning, multiple level operation, and collaborative adaptability. These learning competencies, together, stimulate a student’s cognitive processes of cognitive engagement and attitude, as shown in Figure 4 by the bold bracket pointing from the three learning competencies towards the “Cognitive Processes” box. In Figure 4, a solid arrow leads from the cognitive processes to the “Learning Outcomes” box, illustrating a direct influence. Cumulatively, the learning competencies and cognitive processes aid in a student’s ability to successfully achieve the desired learning outcomes, in terms of measured performance and student satisfaction, for a virtual learning course. Lastly, from the “Satisfaction” subset in the “Learning Outcomes” box in Figure 4, a dashed-line arrow shows a reflective relationship to a student’s attitude towards the virtual learning course.

B. CONCLUSION

The realized cost savings and proven effectiveness of VSH learning will, in all likelihood, remain part of the Navy’s learning structure and likely grow in scope as technology matures and entrenched military paradigms fade or shift. While certain doubt remains among the more traditional elements within the military, the benefits of virtual learning are clear. However, some doubt remains regarding the success of VSH training in terms of student success, whether that success is measured as the students’ satisfaction with the course or in terms of test scores. Our research suggests that students can be successful in the VSH both in terms of satisfaction and performance, and there are certain steps that can be taken by the SLC and the Navy to assist students in achieving both outcomes.

Our research and findings indicate that a student's capability to understand and learn in the virtual world is a significant predictor of his or her success in the virtual environment. We have defined this broad competency as "virtual world efficacy," a student's ability to learn and operate in the virtual world, and believe it is a fundamental, top-tier input to the Bower-Richmond model for student learning in the virtual environment and is illustrated in Figure 4. Given the importance of this competency, we want to illustrate which steps can be taken to assist the student in developing his or her virtual world efficacy with the intent of increasing their satisfaction with the class and their performance in general.

A preliminary review of responses to several of the short answer questions on the post-class surveys and the oral interviews suggests that most students indicated that a block of time dedicated to learning the basic functionality of operating and interacting in the VSH would have contributed to their achieving greater success in the class. Providing a "familiarization period" either at the beginning of the first class or a day or two prior to the VSH course convening would enhance a student's virtual world efficacy and lead to greater success in the classroom. When assessing some of the second-tier competencies or outputs of virtual world efficacy, it is clear, that a block of time dedicated to familiarizing students with synchronous chat, articulation, and general technical abilities terms of competencies can affect other competencies such as self-directed learning, ambiguity (or the removal of ambiguity), proactivity, and confidence. The more comfortable a student feels prior the class commencing, when there is pressure to participate and perform, the more likely he or she is able to achieve a level of virtual world efficacy that will allow him or her to enjoy and perform well in the course. Even the competency, such as synchronous chat, has the potential to contribute enough to a student's virtual world efficacy to influence his/her success.

The effectiveness of a familiarization period prior to commencing the actual course is dependent on some very basic functions that are unique to all VSHs in addition to some that are unique to the SLC and the military in general. Based on our personal observations in the three separate classrooms, there were significant technical difficulties that hindered and sometimes stopped students' entrance into the VSH. These external

factors, while not related to the course content, course material, or even the virtual world, had significant impacts on students' ability to gain access to the virtual world, familiarize themselves, get comfortable, and ultimately increase their virtual world efficacy.

The most common issues were both technical and administrative. For example, some students did not have the proper log-in to gain access to the computer needed for the course. In other situations, some students encountered issues with security clearance verification and other "paperwork" processes that delayed their access.

While not as common, there were also instances where hardware, such as headphones, keyboards, and monitors, would fail. These hardware failures caused additional stress, which had the greatest impact on students already deficient in their virtual world efficacy. In order to achieve the most virtual world efficacy from each student, the SLC should make every attempt to ensure that all administrative, technical, and hardware issues are mitigated to the maximum extent possible prior to the beginning of the class. Avoiding instances that the instructor has to pause to clear up a student's confusion or frustration with some aspect of the course that is not content related or VSH related gives all students, and in particular students with a lower virtual world efficacy, the best chance of achieving success in the VSH.

C. RECOMMENDATIONS FOR FUTURE RESEARCH

The study of synchronous dispersed learning in a military setting is still in its relative infancy. The dramatic increase in popularity of asynchronous dispersed learning institutions, such as the University of Phoenix and a growing number of public institutions, has generated a plethora of available research that has provided a valuable baseline for the SLC, Navy, and military in general to begin to understand its applications in military training. However, there still remains a dearth of research on synchronous learning in the virtual world. This is especially true for military applications. Most studies still focus on synchronous gaming in the virtual world and not an academic setting. Given this lack of research and other differences inherent to the Navy and military, we recommend that the Navy continue to provide access to study, and continue to refine and enhance the VSH competency model.

First, based on the data and our observations we determined that virtual world efficacy was a broad overarching competency from which comprised other competencies such as articulation, synchronous chat, ability, etc. We also speculated that a “familiarization period” before commencement of class has the potential to affect some of the second tier competencies, essentially affecting the top tier competency of virtual world efficacy, leading to greater student and satisfaction and overall performance. The SLC and the Navy could gain significant insight by testing in greater size and scale the effects of a familiarization period on student’s second tier competencies according to the Bower Richmond model and measuring if the development of one or several of these competencies had a positive effect on the student’s virtual world efficacy and his or her satisfaction and performance in the course.

Second, additional steps should also investigate interactivity and collaboration in terms student-to-student competencies as well as the student-to-system and student-to-instructor competencies, previously included in the Spears model, as potential predictors of student success (2014). Student-to-student interactivity and collaboration are increasingly vital forms of learning and problem solving in the classroom and workplace. Future studies could include enhanced opportunities for students to work together on specific problem-solving or decision-making situations related to the class material. Then students’ reaction to these student-to-student learning opportunities could be measured and evaluated. These student-to-student research results could then be used to refine the current Bower Richmond VSH Competencies Model.

Next, while not a student competency, instructor competencies are closely related and should also be measured in future research. Aten and DiRenzo’s research included several indications that instructor competencies can significantly impact each student’s learning experience in the VSH and the authors suggested priming designed to enhance students’ perceptions of instructor competency be included in future research (2014). Instructor competency is a vital key to the success of any learning experience and this competency may be even more important in remote learning settings like VSH.

Additionally, our findings did not identify significant relationships that show influence between autonomous learning and multiple level operation and cognitive

processes and/or learning outcomes. We predict this was due to our small sample size. However, this could be due the nature of a military environment, where rank structure and rigid adherence to classroom procedures may have affected these competencies. Likewise, since the VSH is a synchronous environment, perhaps autonomous learning and multiple level operations are not as profound and significant competencies that contribute to a student's cognitive processes and overall achievement of learning outcomes. Thus, we suggest expansion from this study to obtain a greater sample size to further identify and explore such relationships.

Follow-on research with broad access to students and consistent monitoring of student success in the virtual classroom is not only critical to a successful classroom learning experience, but is also vital to the safe and effective operation of submarines and all other U.S. naval assets. It is essential that the while offering a cost savings, the SLC and the Navy ensure service members have the best training and chance to succeed in the VSH.

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APPENDIX A. PRE-TRAINING SURVEY QUESTIONNAIRE

SECTION 1

Please circle your response to the following questions.

How many times in the past year have you done the following:

1. Played a PC based video game?

Never Seldom Sometimes Frequently Often

2. Played a console video game system (e.g., XBox, PlayStation 3, Wii, etc...)?

Never Seldom Sometimes Frequently Often

3. During an average week, how many hours will you spend playing video games ?

< 1 hour 1-3 hours 3-5 hours 5-7 hours 7-9 hours > 9hours

4. I consider myself:

- A. A non-video game player
- B. A novice video game player
- C. An occasional video game player
- D. A frequent video game player
- E. An expert video game player

SECTION 2

Please respond by circling the number that corresponds with the extent to which you agree with the following statements on a scale from 1 = strongly disagree to 5 = strongly agree.

Many of the following statements are very similar to one another. This is necessary to ensure the validity of the study's results.

1. I am confident I get the success I deserve in life.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

2. When I try, I generally succeed.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

3. I complete tasks successfully.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

4. Overall, I am satisfied with myself.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

5. I determine what will happen in my life.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

6. I am capable of coping with most of my problems.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

SECTION 3

1. I prefer to do things that I can do well rather than things that I do poorly.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

2. I'm happiest at work when I perform tasks on which I know that I won't make any errors.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

3. The opportunity to do challenging work is important to me.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

4. When I fail to complete a difficult task, I plan to try harder the next time I work on it.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

5. I prefer to work on tasks that force me to learn new things.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

6. The things I enjoy the most are the things I do the best.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

7. The opinions others have about how well I can do certain things are important to me.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

8. I feel smart when I do something without making any mistakes.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

9. I like to be fairly confident that I can successfully perform a task before I attempt it.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

10. The opportunity to learn new things is important to me.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

11. I do my best when I'm working on a fairly difficult task.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

12. I try hard to improve on my past performance.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

13. I like to work on tasks that I have done well on in the past.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

14. I feel smart when I can do something better than most other people.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

15. The opportunity to extend the range of my abilities is important to me.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

16. When I have difficulty solving a problem, I enjoy trying different approaches to see which one will work.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

SECTION 4

1. Compared to most people, I am typically unable to get what I want out of life?

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

2. Growing up, I would “cross the line” by doing things that my parents would not tolerate?

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

3. I have often accomplished things that got me "psyched" to work even harder?

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

4. I got on my parents’ nerves often when I was growing up?

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

5. I obeyed rules and regulations that were established by your parents?

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

6. Growing up, I often acted in ways that my parents thought were objectionable?

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

7. Do you often do well at different things that you try?

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

8. Not being careful enough has gotten me into trouble at times.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

9. When it comes to achieving things that are important to me, I find that I don't perform as well as I ideally would like to do.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

10. I feel like I have made progress toward being successful in my life.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

11. I have found very few hobbies or activities in my life that capture my interest or motivate me to put effort into them.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

SECTION 5

1. During class time I often miss important points because I'm thinking of other things.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

2. When reading for this course, I make up questions to help focus my reading.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

3. When I become confused about something I'm reading for this class, I go back and try to figure it out.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

4. If course materials are difficult to understand, I change the way I read the material.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

5. Before I study new course material thoroughly, I often skim it to see how it is organized.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

6. I ask myself questions to make sure I understand the material I have been studying in this class.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

7. I try to change the way I study in order to fit the course requirements and instructor's teaching style.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

8. I often find that I have been reading for class but don't know what it was all about.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

9. I try to think through a topic and decide what I am supposed to learn from it rather than just reading it over when studying.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

10. When studying for this course I try to determine which concepts I don't understand well.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

11. When I study for this class, I set goals for myself in order to direct my activities in each study period.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

12. If I get confused taking notes in class, I make sure I sort it out afterwards.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

SECTION 6

I would feel confident...

1. Opening a web browser (e.g. Firefox or Explorer).

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

2. Reading text from a website.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

3. Clicking on a link to visit a specific website.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

4. Conducting an Internet search using one or more keywords.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

5. Creating a simple web page with text, images, and links.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

SECTION 7

I would feel confident...

1. Providing a nickname within a synchronous chat system (if necessary).

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

2. Reading messages from one or more members of the synchronous chat system.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

3. Answering a message or providing my own message in a synchronous chat system (one-to-many interaction).

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

4. Interacting privately with one member of the synchronous chat system (one-to-one interaction).

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

SECTION 8

I would feel confident...

1. Moving my avatar in a virtual world or a computer simulation.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

2. Adjusting my camera angle in a virtual world or a computer simulation.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

3. Adjusting the view of my avatar in a virtual world or a computer simulation.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

4. Focusing on/zooming in on an object in a virtual world or a computer simulation.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

5. Navigating around objects in a virtual world or a computer simulation.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

SECTION 9-A

1. I am comfortable using different technological tools in a virtual classroom.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

2. I can excel in a virtual classroom because I know how to use many different technological tools.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

3. I do NOT know how to use virtual classroom tools.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

SECTION 9-B

1. I am confident I can use technology (email, chat, virtual environments, etc.) to communicate effectively with others.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

2. I am confident I can use technology (email, chat, virtual environments, etc.) to interactively solve problems with others.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

3. I can get work done with others using technology (email, chat, virtual environments, etc.) just as well as I can when working face-to-face.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

SECTION 10-A

1. I consciously articulate my thoughts differently online as opposed to in person.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

2. I adjust my approach to communicate with others online.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

3. I am more deliberate in the ways I communicate and express my thoughts online.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

SECTION 10-B

1. I find it easy to switch between multiple conversations in a virtual world.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

2. I can handle multiple tasks simultaneously in a virtual world.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

3. I feel comfortable conversing over multiple channels (e.g., chat, voice, email, text, etc.) at the same time.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

SECTION 10-C

1. I feel comfortable learning in a digital world.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

2. I feel comfortable seeking additional clarification when a situation in the virtual world confuses me.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

3. I feel comfortable dealing with the ambiguity associated with learning in a virtual world.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

SECTION 10-D

1. I enjoy changes in job policies, procedures or practices.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

2. I like it when the structure of my work changes.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

3. It is easy for me to adapt when my job tasks change.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

4. I appreciate when the work I do in my job changes.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

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APPENDIX B. POST-TRAINING SURVEY QUESTIONNAIRE

Please respond by circling the number that corresponds with the extent to which you agree with the following statements on a scale from 1 = strongly disagree to 5 = strongly agree.

Many of the following statements are very similar to one another. This is necessary to ensure the validity of the study's results.

SECTION 1

1. I had numerous interactions with the instructor during the class.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

2. I asked the instructor my questions through different electronic means, such as email, discussion board, instant messaging tools, etc.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

3. The instructor regularly posted some questions for students to discuss on the discussion board.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

4. The instructor replied my questions in a timely fashion.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

5. I replied to messages from the instructor.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

6. I received enough feedback from my instructor when I needed it.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

SECTION 2

1. Virtual schoolhouse course materials helped me to understand the class content.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

2. Virtual schoolhouse course materials stimulated my interest in this course.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

3. Virtual schoolhouse course materials helped me relate my personal experience to new concepts or new knowledge.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

4. It was easy for me to access the virtual schoolhouse course materials.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

SECTION 3-A

1. The Virtual School House excites my curiosity.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

2. The Virtual School House arouses my imagination.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

3. Learning with the Virtual School House makes me curious.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

SECTION 3-B

1. When using the Virtual School House, I am totally absorbed in what I am learning.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

2. The Virtual School House holds my attention.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

3. When learning with the Virtual School House, I am aware of distractions.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

SECTION 3-C

1. The Virtual School House is fun.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

2. The Virtual School House is interesting.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

3. The Virtual School House is boring.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

SECTION 4-A

1. Using the Virtual School House is pleasurable.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

2. Using the Virtual School House is a positive experience.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

3. I enjoy using the Virtual School House.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

SECTION 4-B

1. The Virtual School House is a useful tool for learning tasks related to my job.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

2. The Virtual School House is beneficial.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

3. The Virtual School House is a valuable resource for learning new skills.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

SECTION 5

1. The course instructors are competent teachers.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

2. I learned a lot because of the quality of the course instructors.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

3. I would recommend these course instructors to future students.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

SECTION 6

1. The course instructors were passionate about this course.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

2. The course instructors seemed to enjoy teaching this course.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

3. The course instructors had a positive view of this course.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

4. The instructors valued this course.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

SECTION 7

1. Using the Virtual School House increased my learning and productivity.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

2. Using the Virtual School House improved my performance and skills.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

3. Using the Virtual School House enhanced my effectiveness.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

4. I find the Virtual School House useful to my learning and development.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

SECTION 8

1. Learning to operate the Virtual School House is easy for me.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

2. I find it easy to get the Virtual School House to do what I want it to do.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

3. It would be easy for me to become skillful at using the Virtual School House.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

4. I find the Virtual School House easy to use.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

SECTION 9

1. The course instructors were passionate about the Virtual School House.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

2. The course instructors seemed to enjoy using the Virtual School House.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

3. The course instructors had a positive view of the Virtual School House.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

4. The instructors valued the Virtual School House.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

SECTION 10

1. Overall, I am satisfied with this course.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

2. This course contributed to my educational development.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

3. This course contributed to my professional development.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

4. I am satisfied with the level of interaction that happened in this course.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

5. In the future, I would be willing to take a course like this again.

Strongly Disagree **1** **2** **3** **4** **5** *Strongly Agree*

APPENDIX C. INTERVIEW QUESTIONS

Describe your experience overall.

What tools did find the most useful?

When did you find you would have preferred face-to-face training?

What features or tools were distracting?

What features would you have liked to have had?

Thinking back on the training, can you tell me about a time that you were confused?

What happened? How did you overcome it?

What contributed most to your learning in the VSH?

How was this different from face-to-face training?

What was distracting or difficult in the VSH?

How was this different from the face-to-face training?

Can you give me an example of a time that something didn't work for you in the VSH?

An example of something that didn't work in the previous face-to-face?

Can you think about something that worked really well in the VSH? What happened?

What features did you use?

What was missing (compared to face-to-face)?

What was added or better (compared to face-to-face)?

Which features were most useful?

Which features were least useful?

Which were distracting?

What did you most enjoy?

What did you least enjoy?

What would you change?

How could it be improved?

How will this experience influence your interest/ability in using the VSH in the future?

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APPENDIX D. CORRELATION DATA

Table 2. Correlation Data between All Learning Competencies
Derived from Student Surveys (where p -value ≤ 0.05)

r	Gaming	Self-Regulated Learning	Internet Competency	Synchronous Chat	Virtual World Efficacy	Operational	Interactional	Articulation	Multiple Levels	Ambiguity	Adaptability
Gaming	1	.015	.066	.149	.287	.180	.398	.176	.345	.267	-.092
Self-Regulated Learning	.015	1	.459	.341	.283	.184	.384	.147	.350	.244	.465
Internet Competency	.066	.459	1	.658	.736	.589	.750	.318	.515	.679	.339
Synchronous Chat	.149	.341	.658	1	.679	.485	.695	.346	.538	.637	.155
Virtual World Efficacy	.287	.283	.736	.679	1	.771	.853	.246	.642	.781	.092
Operational	.180	.184	.589	.485	.771	1	.688	.297	.771	.792	-0.12
Interactional	.398	.384	.750	.695	.853	.688	1	.404	.751	.770	.202
Articulation	.176	.147	.318	.346	.246	.297	.404	1	.467	.396	.251
Multiple Levels	.345	.350	.515	.538	.642	.771	.751	.467	1	.844	.320
Ambiguity	.267	.244	.679	.637	.781	.792	.770	.396	.844	1	.336
Adaptability	-.092	.465	.339	.155	.092	-.012	.202	.251	.320	.336	1

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